## Description

# TURBOCHARGER ASSEMBLY AND METHOD

### U.S. Government Rights

[01] This invention was made with government support under the terms of Contract No. DE-SC05-00OR-22810 awarded by the Department of Energy. The government may have certain rights in this invention.

### Technical Field

[02] The present invention is directed to a turbocharger assembly and, more particularly, to a turbocharger assembly that provides for removably connecting a turbine wheel assembly to a turbocharger drive.

### Background

[03] Internal combustion engines such as, for example, diesel engines, gasoline engines, or natural gas engines may be operated to generate a power output. In order to maximize the power generated by the internal combustion engine, the engine may be equipped with a turbocharged air induction system.

[04] A turbocharged air induction system may include a turbocharger that compresses the air flowing into the engine to thereby force more air into a combustion chamber. The increased supply of air allows for increased fuelling, which may result in increased power. A turbocharged engine typically produces more power than the same engine without turbocharging.

[05] A turbocharger may include a turbine wheel that is connected to a compressor. The expansion of hot exhaust gases over the turbine wheel drives the compressor wheel to force compressed air into a combustion chamber. A typical turbocharger includes a housing, a shaft, a turbine wheel attached to one end of the shaft, and a compressor connected by threaded fastening to the other end of the shaft. The turbine, shaft, and compressor may be assembled into the

housing as described in U.S. Patent No. 5,193,989 issued to Fleury et al. on March 16, 1993. The '989 patent to Fleury et al. describes assembly of a turbocharger having the turbine wheel permanently attached to the shaft. The shaft and turbine wheel may be inserted from one side of the housing and the compressor wheel may be fastened to the other end of the shaft.

[06] However, the turbocharger of Fleury et al. does not allow for the design flexibility required for more complex turbocharging systems that require additional components. Adding the additional components to the turbocharger systems of Fluery et al. may be difficult because the turbocharger components may only be assembled from one end of the turbocharger shaft. Additionally, the turbocharger of Fleury et al. may be too expensive to maintain when combined with more complex air induction systems because the turbine wheel and shaft are inseparable.

[07] The turbocharger assembly of the present invention solves one or more of the problems set forth above.

Summary of the Invention

[08] A first aspect of the present disclosure is directed to a turbine assembly. The turbine assembly includes a turbocharger drive having a first threaded portion and a turbine wheel assembly. The turbine wheel assembly includes a turbine wheel and a second threaded portion adapted to engage the first threaded portion of the turbocharger drive.

[09] A second aspect of the present disclosure is directed to a method of assembling a turbocharger. The method includes inserting a drive into a main housing, wherein the turbocharger drive includes a first end having a first threaded portion and a second end. A second threaded portion of a turbine wheel assembly is engaged with the first threaded portion of the turbocharger drive. A compressor is connected to the second end of the turbocharger drive.

Brief Description of the Drawings

[10] Fig. 1 is a cross-sectional illustration of a turbine assembly in accordance with an exemplary embodiment of the present invention.

[11] Fig. 2 is a cross-sectional illustration of a turbine assembly in accordance with an exemplary embodiment of the present invention.

[12] Fig. 3 is a cross-sectional illustration of a turbocharger in accordance with an exemplary embodiment of the present invention.

[13] Fig. 4 is a diagrammatic and schematic illustration of an engine system in accordance with an exemplary embodiment of the present invention.

Detailed Description

[14] An exemplary embodiment of a turbine wheel assembly 10 is illustrated in Fig. 1. The turbine wheel assembly 10 includes a turbine wheel 11 having a turbine wheel base 12 and a plurality of turbine blades 13. The plurality of turbine blades 13 may be disposed on the outer periphery of the turbine wheel base 12 and may be adapted to rotate the turbine wheel base 12 when driven by the expansion of hot exhaust gases. The plurality of turbine blades 13 may be rigidly fixed to the turbine wheel base 12 using conventional means or they may be movable with respect to the turbine wheel base 12 such as, for example, by providing variable pitch turbine blades or variable geometry turbine blades. The plurality of turbine blades 13 may also be integral with the turbine wheel base 12.

[15] The turbine wheel assembly 10 may also include a connecting means such as for example, a threaded portion 14. The threaded portion 14 may be integral to turbine wheel base 12 or may be connected to the base through any means known in the art such as, for example, inertia welding. The threaded portion 14 may be adapted to transmit power from the turbine wheel assembly 10 to a corresponding connecting member.

[16] In the embodiment of Fig. 1, the threaded portion 14 of the turbine wheel assembly 10 is adapted to engage a corresponding connecting means of a

turbocharger drive 18. In this embodiment, the connecting means is a threaded portion 16. When the threaded portion 14 of the turbine wheel assembly 10 is engaged with the threaded portion 16 of the turbocharger drive 18, the turbine wheel assembly 10 is connected to the turbocharger drive 18 so that a rotation of the turbine wheel assembly 10 will cause a corresponding rotation of the turbocharger drive 18.

[17] In the exemplary embodiment of Fig. 1, the threaded portion 14 of turbine wheel assembly 10 has male threads and the threaded portion 16 of the turbocharger drive 18 has female threads. The male threads of the turbine wheel assembly 10 may be engaged with the female threads to connect the turbine wheel assembly 10 to the turbocharger drive 18. The turbine wheel assembly 10 may alternatively have a female threaded portion adapted to engage a male threaded portion of the turbocharger drive 18.

[18] Another exemplary embodiment of a turbine wheel assembly 10 is illustrated in Fig. 2. The turbine wheel assembly 10 of this embodiment includes a turbine wheel 11 and a stub shaft 20 having a threaded portion 22. The stub shaft 20 may be integral to turbine wheel base 12 or may be connected to turbine wheel base 12 by any manner known in the art such as, for example, inertia welding. The stub shaft 20 may include a female threaded portion 22 adapted to engage a male threaded portion 16 located on the turbocharger drive 18 (referring to Fig. 1), thereby connecting the turbine wheel assembly 10 to the turbocharger drive 18. Alternatively, the stub shaft 20 may include a male threaded portion adapted to engage a female threaded portion located on the turbocharger drive 18.

[19] It is contemplated that the turbine wheel assembly 10 may be incorporated in a turbocharger assembly. An exemplary embodiment of a turbocharger 23 is illustrated in Fig. 3. In this embodiment, the turbocharger 23 includes a stator housing 24 in which a pre-assembled drive assembly 26 may be inserted.

[20] The pre-assembled drive assembly 26 may have a stator 28 and a rotor 29 held by end plate retainers 34 between bearings 30. The stator 28, rotor 29, end plate retainers 34, and bearings 30 are assembled to the turbocharger drive 18. The pre-assembled drive assembly 26 may be adapted to generate power when the turbocharger drive 18 is rotated and direct the power to a crankshaft of an engine 46 (referring to Fig. 4) to which the turbocharger 23 is attached.

[21] A turbine housing 40 is assembled to stator housing 24 to enclose turbine wheel assembly 10. The turbine housing 40 is adapted to direct hot expanding exhaust gases through a turbine exhaust inlet 41 to the plurality of turbine blades 13 disposed on the turbine wheel base 12 to cause the turbine wheel assembly 10 and associated turbocharger drive 18 to rotate. After passing through the turbine wheel assembly 10, the exhaust gases are released to the atmosphere through a turbine exhaust outlet 42.

[22] A compressor assembly 37 may be connected to the other end of the turbocharger drive 18 and be adapted to rotate with the turbocharger drive 18. The compressor assembly 37 may include a compressor wheel base 38 and a plurality of compressor blades 39 disposed around the outer periphery of the compressor wheel base 38. Compressor assembly 37 may also include a stub shaft (not shown) having a fastening means such as for example, threads, similar to stub shaft 20 connected to turbine wheel 11. The stub shaft of compressor assembly 37 may be adapted to connect the compressor assembly 37 to the turbocharger drive 18.

[23] A compressor housing 43 may be assembled to the stator housing 24 that encloses compressor assembly 37. Compressor housing 43 is adapted to direct ambient air from a compressor air inlet 44 to the plurality of compressor blades 39 attached to the rotating compressor wheel base 38. The plurality of compressor blades 39 may be operable to compress the air and force the

compressed air out of the turbocharger 23 through a compressor air outlet 45 (referring to Fig. 4).

[24] As illustrated in Fig. 4, the turbocharger 23 of the present disclosure may be used with an engine 46 in an engine assembly 48. The engine 46 may be a diesel engine, a gasoline engine, a natural gas engine, or any other engine known in the art. Hot exhaust gases from the engine 46 are directed into the turbine exhaust inlet 41 where the gases drive the rotation of the turbine assembly 10 resulting in a corresponding rotation of compressor assembly 37. The rotation of compressor assembly 37 compresses inlet air and forces the compressed air into the engine 46 through compressor air outlet 45.

Industrial Applicability

[25] As will be apparent from the foregoing description, the present disclosure provides a system and method that allows for design flexibility and low cost maintenance of a turbocharger 23.

[26] The turbocharger 23 of the present disclosure may be assembled from both ends of the turbocharger drive 18. The pre-assembled drive assembly 26 (having stator 28, rotor 29, end plate retainers 34, bearings 30, and turbocharger drive 18) is balanced and then inserted into stator housing 24. Turbine wheel assembly 10 is connected to one end of the turbocharger drive 18 by engaging threaded portion 14 of the turbine wheel assembly 10 with threaded portion 16 of the turbocharger drive 18. Turbine housing 40 is assembled to one side of the stator housing 24 and encloses the turbine wheel assembly 10. Compressor assembly 37 may be connected to the other end of the turbocharger drive 18 and enclosed by compressor housing 43 assembled to the other side of the stator housing 24.

[27] Because the turbocharger 23 can be assembled from both sides of the turbocharger drive 18, design flexibility is expanded. Design is no longer

limited to components capable of assembly from only one direction. Likewise, methods of assembly are no longer limited to only one direction of assembly.

[28] In addition to increased design flexibility, maintenance costs of the turbocharger 23 may be reduced by the ability to remove both the turbine wheel assembly 10 and the compressor assembly 37 from the turbocharger drive 18. For example, when maintaining a turbocharger having a turbine wheel permanently secured to a turbocharger drive, replacement of a damaged turbine wheel required the entire turbocharger be taken apart. Both turbine and compressor housings had to be removed and the compressor assembly had to be disconnected from the turbocharger drive. The pre-assembled drive assembly had to be removed from the stator housing along with the turbine wheel and the turbocharger drive. The pre-assembled drive assembly had to be separated from the turbocharger drive. Finally the turbine wheel and turbocharger drive could be replaced.

[29] With the turbine wheel assembly 10 detachable from the turbocharger drive 18 as described in the present disclosure, the maintenance process is simplified. For example, when replacing a broken or damaged turbine wheel assembly 10, the turbine housing 40 is removed and the turbine wheel assembly 10 is detached. Not only is the process simplified saving time and labor cost, but part cost is also reduced.

[30] It will be apparent to those skilled in the art that various modifications and variations can be made in the turbine wheel assembly 10 of the present disclosure without departing from the scope of the invention. Other embodiments of the invention will be apparent to those skilled in the art from consideration of the specification and practice of the invention disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope of the invention being indicated by the following claims and their equivalents.